GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: June 27, 1979

Project Title: MIS Effectiveness

Project No: E-24-689

Project Director: Dr. D. Sipper

Sponsor: Battelle Columbus Laboratories; Columbus, OH 43201

Agreement Period: From 6/13/79 Until 9/10/79

Type Agreement: Delivery Order No. 1269 (Time and Materials Subcontract under Prime DAAG29-76-D-0100)

Amount: $9,894 Ceiling Price

Reports Required: Summary of Results; Final Report

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Defense Priority Rating: None

Assigned to: Industrial and Systems Engineering (School/Laboratory)

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MIS SOFTWARE EFFECTIVENESS

Final Report - Delivery Order No. 1269-01
DAAG 29-76-D-0100

Presented to

Dr. Clarence Giese, Director, AIRMICS
Major Edward H. Ely, COTR

Presented by

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10 September 1979

Security Classification: UNCLASSIFIED

EXECUTIVE SUMMARY

The purpose of this project was to investigate state of the art of MIS software effectiveness evaluation criteria and assess the desirability of embarking on an expanded MIS software effectiveness project in the future.

Those objectives were achieved in four phases: first, a management information metrics was developed. Then, the current available measurement techniques were analyzed. The third phase included an assessment of the extent to which available techniques can evaluate management information attributes (summarized in Table 7-4), and the outcome of this phase was identification of research needs. Finally, the fourth phase recommends guidelines for a larger MIS effectiveness project.

The measurement techniques analyzed were classified into four groups: economic, behavioral, other and management science. After examining about seventeen different techniques, the following major findings were arrived at:

- there is no single satisfactory approach that can measure and evaluate MIS software effectiveness from the user's perspective, mainly because of deficiencies in establishing the theoretical metric and shortcomings of the measuring devices.
- development of surrogate measures to evaluate effectiveness is a promising direction to pursue.

- no methodology exists for evaluating the effectiveness of the system based upon measurement of the system attributes.

Research needs were defined in the form of "research clusters," where each cluster represents a number of related research topics. Four such clusters were identified - measurement, effectiveness, design phase and future trends cluster.

Recommended guidelines for the MIS effectiveness project include four "modules" - a project module for each research cluster. It is further recommended that an MIS software effectiveness project be designed and implemented following the modular structure. The project implementation policy could use a parallel approach - implementing all four modules at the same time, or a sequential approach - one module at a time, where the priorities are:

- Measurement module
- Effectiveness module
- Design Phase module
- Future Trends module

The sequential approach is recommended. Furthermore, it is recommended that the first two modules be implemented concurrently.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

The United States Army Institute for Research in Management Informatin and Computer Science (AIRMICS) has initiated an exploratory research in the area of management information systems (MIS) software effectiveness. The major objectives of this research are to establish MIS software-effectiveness evaluation state-of-the-art and assess the desirability of embarking on an expanded MIS effectiveness project in the future.

1.2 Motivation

The motivation for performing this research stems from the recognition that there is a clear need in the Army to identify, develop and implement methods to evaluate MIS software effectiveness, not only related to current operations, but also with a view towards future developments, namely, computer technologies, distributed systems and modern communication interfaces. Furthermore, this research relates to some USACSC command objectives and is further supported by the findings and recommendations of the Second Software Life Cycle Management Workshop.

1.3 Methods and Scope

The amount of effort allocated to this study was restricted to sixty man days between the period 15 June and 10 September 1979. The major part of the effort was devoted to a comprehensive literature search and analysis and reporting of the findings, and discussions with AIRMICS personnel. The balance of the effort was allocated to visits to U.S. Army installations - Fort McPherson in Atlanta, Georgia, and Fort Hood, Texas, where discussions were held with the personnel there. The objective of these discussions was to obtain a feel of the user's perspective of MIS effectiveness.

1.4 Organization of the Report

Chapter 2 describes the environment within which the current military MIS (STAMMIS) is used. Chapter 3 summarizes the literature search effort. Chapter 4 combines a discussion of the nature of the decision making process with the history of MIS to present some current problems in MIS. Chapter 5 discusses some basic concepts related to MIS evaluation and presents a management information metrics. Chapter 6 presents the state-of-the-art in MIS effectiveness evaluation techniques. Chapter 7 assesses those techniques in relation to the management information metrics. Chapter 8 discusses various topics related to MIS effectiveness. Finally, Chapter 9 identifies research needs, and Chapter 10 recommends and gives guidelines for an MIS effectiveness project. A bibliography list is included also.

2. THE SYSTEM ENVIRONMENT

The system environment related to this research is a multicommand system composed of DA, MACOMS, CSC, proponent agencies, DPI and more. Each component of the system is either information producer or information user or both. It is obvious that the information requirements will vary between the various components of the system and within them. However, one should realize that information is the life blood system that connects the different information users, i.e., the decision makers. The information flow is handled by STAMMIS - Standard Army Multicommand Management Information System.

Some criticism has recently been leveled at this system, especially from lower echelons, where the major concern is that the system has a "stove-pipe" feature, i.e., lower echelons feed the pipe with information that services the needs of a higher level of the organization, but do-not provide any benefit to the "feeding echelons."

An example of this concern is seen in an extract from the Fort Hood IMS report (March 1979), as follows:

> Most STAMMIS are considered to be inadequate management tools at installation level because they are:
>
> 1. Designed to support functional management at DA level, not at installation level.
> 2. Vertically structured to support a very narrow segment of the functional responsibility associated with installation management.
> 3. Independent and have little communication or interface between systems.

4. Collectors and reporters of data without comparison to a previously established standard or reference point; they tend to be conduits for transmitting great quantities of raw data.

5. Predominantly operational systems rather than management systems.

Despite the obvious weaknesses of the existing information systems for installation management, they are not changeable through local action and must therefore be used as presently observed.

This lengthy quote does not mean endorsing the deficiencies identified. However, it does present perceived dissatisfaction of a major user from the current MIS, and indicates the need to identify available techniques of evaluating MIS software effectiveness, and identify research needs in this area, from the user's point of view. The balance of this report addresses this problem.

3. LITERATURE SURVEY

3.1 Introduction

The literature survey presented here does not follow the regular approach of a brief description of each one of the relevant references. The reason is that in this study, a major part is establishing the "state-of-the-art" in MIS software effectiveness, and therefore it was found to be more beneficial to describe the relevant references along with the specific topic investigated. This way a better relationship between topics and references can be established. Therefore, this chapter will concentrate on the literature search effort that was done, and will give a general frame of reference to the various literature sources.

The literature search effort included the following activities:

1. Computerized literature search of five "data bases," as follows: NTIS, MGMT CONTENTS, COMPENDEX, INSPEC, ABI/INFORM
2. DDC computerized literature search
3. Manual library search.

This effort yielded about 300 references. Initial screening reduced this number to about 50, which were closely reviewed. All the references that were reviewed are listed in the bibliography list. Out of this list, about 30 references are cited in the report for specifics, and the rest were used as a general background material.

3.2 References Grouping

In order to introduce some structure into the reference list, grouping was performed, and the references were divided into five groups as follows:

1. MIS Evaluation - includes those references that are mainly concerned with various aspects of the evaluation process.
2. Future Trends
3. MIS - references that deal with general MIS issues, and that were useful in the investigation of this study. This is not a comprehensive list, as the area is "flooded" with publications, however, most of them were found to be irrelevant to the evaluation issue.
4. Cost Benefit
5. Miscellaneous - different reference, less specific, that were found to be related to the current study.

The classification of the references is given in Table 3-1. In each group, the references are arranged in descending order of their year of publication. Each reference has a one or two word description of its major thrust, and also a classification whether it's a book (B), paper, report, article etc. (P), or a Ph.D. dissertation (D). Additional information about each reference can be obtained by inspecting the Bibliography list, or by reading the text for those references that were cited. (Note: in case of two authors or more, only the first one is listed in Table 3-1).

In general, the references that proved to be most useful to this research are: Dumas (1978), Liggon (1978), Keen (1975) King and Clealand (1975), Lucas (1975), Mason (1973), Parden (1978), Murdick and Ross (1975), Davis (1974), U.S. Army Report (Fort Hood 1979), Anthony (1963).

Table 3-1. Literature Search - Survey

MIS Evaluation		Future Trends	MIS	Cost Benefit	Miscellaneous
Dumas 1978 Evaluation (D)	Stabel 1974 Interactive (D)	Blackwell 1978 Development (P)	Ein Dor 1978 General (B)	Masson 1978 CB	U.S. Army 1979 User's Report (P)
Liggon 1978 Evaluation (B)	Swanson 1974 Appreciation (P)	Parden 1978 Growth Limits (P)	Keen 1978 DSS (B)	Sassone 1978 CB (B)	Andersen 1978 Expectations (P)
Kitous 1976 Display (D)	Goldberg 1973 Evaluation (D)	Walsh 1978 Trends (P)	Lucas 1976 Design (B)	McFadden 1978 CB (P)	Lockett 1978 Metrics (P)
Ginzberg 1975 Implementation (D)	Mason 1973 MIS Research (P)	Smith 1973 Trends (P)	Murdick 1975 General (B)	Quade 1975 Cost Effec. (P)	Drucker 1977 Management (B)
Keen 1975 Evaluation (P)	Seward 1973 Satisfaction (D)		McDonald 1975 Military (P)	U.S. Army 1971 Cost Effec. (P)	Gilb 1977 Metrics (B)
Kennedy 1975 Inf. Analysis (P)	Walther 1973 Satisfaction (D)		Sprague 1975 Concepts (P)		Watson 1977 Performance (P)
King 1975 Design (P)	Golding 1972 Evaluation (P)		Davis 1974 General (B)		Drezner 1976 Military Sys. (P)
Lucas 1975 Evaluation (B)	Knebel 1971 Evaluation (R)		Demski 1972 Information (B)		Lientz 1975 Trade offs (P)
Gallagher 1974 Value (P)	Feltham 1968 Information (P)		Cohen 1971 General (B)		Anthony 1963 Management (B)
Courbon 1974 Evaluation (D)	Boyd 1963 Simulation (P)		Bonini 1963 Simulation (B)		Simon 1963 Management (B)
			McDonough 1963 Inf. Econ. (B)		

4. EVOLUTION OF MIS

4.1 Introduction

The concept of Management Information Systems is one of those ambiguous terms that means different things to different people, and apparently could be compared to the ambiguity of the term "system analysis." The literature is full of various definitions of MIS. For the purpose of this study, the definition given by Davis (1974) seems to be most appropriate.

> A management information system, or MIS, is an information system that, in addition to providing all necessary transaction processing for an organization, provides information and processing support for management and decision functions. The idea of such an information system preceded the advent of the computers, but computers made the idea feasible.

The above definition implies that MIS is <u>not</u> merely a data processing activity, but an activity that has to supply information in order to support the managerial decision process. Furthermore, the concept of information supporting management decisions existed long before the computer era. In a way, it might be claimed that the essence of the decision making process has not changed that much over the years. The big change has been in the tools and understanding of the process.

To gain further understanding of the current status of MIS, first the decision making process is reviewed, followed by the history of MIS, culminating with a discussion of some of the problems in this area.

4.2 The Decision Making Process

No attempt is going to be made here to present a comprehensive examination of the decision making process. However, in order to be able to evaluate MIS effectiveness, one has to have an appreciation of the process MIS is supposed to serve - especially within a military environment. Following is a brief description of some of the current approaches and theories describing this process, with an emphasis on the information needs.

Simon (1965) has described three major components of the decision making process, as follows:

- Intelligence; involves searching the environment or becoming aware of the situation that requires a decision.
- Design; the decision maker has to enumerate and evaluate the alternatives available.
- Choice; the decision maker selects from the alternatives delineated during design.

It might be useful to add another step to Simon's model - implementation, the process of carrying out the decision.

Information systems have the potential for supporting all parts of the decision making process outlined above.

Simon's approach to the decision making process is technical in nature. The more conceptual approaches are summarized very well in Keen and Morton (1978). Five views of the decision making process are presented as follows:

- The economic, rational concept; Decision makers are all knowing and able to evaluate all alternatives. They are dissatisfied with any solution but the best. This approach represents the classical normative theory of decision making. (Described in early works of Cyert, Simon and Trow)

- The satisficing concept; This is a process oriented view, where decision makers are considered to be rational, although cognitive limits lead to a "bounded rationality," making a decision maker desire to get a good enough answer, not the best possible one. (Simon's approach)
- The organizational procedure concept; This approach highlights the organizational structure formal and informal mechanisms for communication and coordination, and the standard operating procedures by which decision making is systematized (Cyert and March's "A Behavioral Theory of the Firm" is the most complete statement of this approach.)
- The political concept; The participants in the decision making process are regarded as actors with parts to play. Coalitions or organizational subgroups are formed, and decisions are frequently dominated by bargaining and conflict, resulting with only minor changes in the status quo. (A good definition of this concept is given in Allison G.T.: Essence of Decisions, 1971)
- The individual differences concept; The claim here is that an individual's personality and style strongly determine his or her choices and behavior, which is very much determined by the manner in which an individual processes information. (See for example, Schroder, Driver and Steufert: "Human Information Processing," 1967)

Obviously, those approaches to the decision making process are not mutually exclusive. They vary from the entirely normative to the entirely descriptive. The real problem is not to develop one grand all inclusive theory, but to be aware of the many paths through it. Certain systems can be described better by one approach, and others by a different one.

Military systems may be better described, but not necessarily better understood, by the organizational procedure concept. The management process associated with this concept can be viewed as composed of five functions:

- planning
- organizing
- staffing
- directing
- controlling

Within this context of activities, it is possible to identify three types of management decisions that have to be supported by information systems:

- technical
- tactical
- strategic

A further insight into management decisions is given by Drucker (1977) who identified three categories:

- Operational Decisions: not really decisions, because they involve no risk and are programmable
- Managerial Decisions: primarily deal with the allocation of resources including people, for which there is no "right" answers, and therefore they involve risk.
- Entrepreneural Decisions: have no right answer; one seeks to take the right risk to innovate and change the trend rather than follow or anticipate it.

Those types of decisions require <u>two</u> types of information systems, defined as:

- programmable, or operations systems
- nonprogrammable, or management information systems

Both support the function of "management," however, management information systems support decision making by managers - a much more difficult task. Parden (1978) describes this distinction on a continuum of organizational styles (after Desler), as follows:

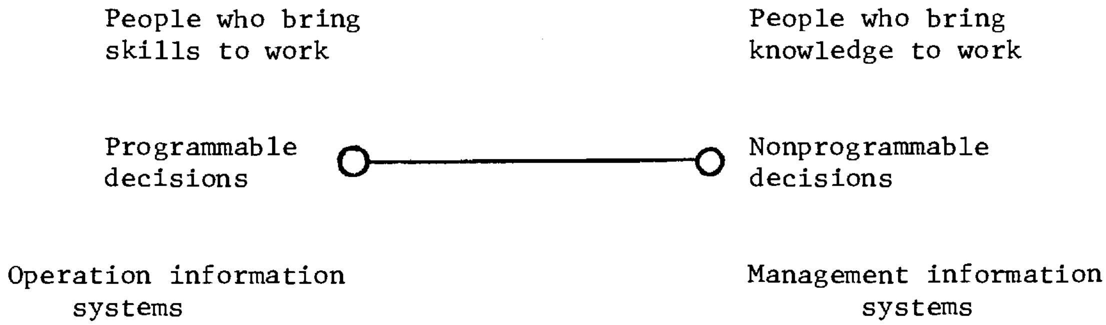

Figure 4-1. Continuum of Organizational Styles

This continuum should be observed when the effectiveness of MIS is going to be considered much so because the cost effectiveness of operations systems can readily be determined, while the value of information supporting management decision making is always vague.

To conclude this discussion of the decision making process, it is worthwhile to consider it from the <u>decision maker</u> point of view and <u>not</u> the <u>decision making</u>. According to Mason and Mitroff (1978) the decision maker is

> .... one person of a certain psychological type who faces a problem within some organizational context for which he needs evidence to arrive at a solution, and that evidence is made available to him through some mode of presentation.

Following the concepts developed by Churchman, they present five archetypal ways of modeling and generating evidence for any problem. These archetypal ways are labelled "inquiring systems" (IS) defined as follows:

- Lockean IS: - are experimental, consensual systems
- Leibnitizian IS: - are formal, symbolic systems
- Kamtian IS: - multi model, synthetic systems
- Hegelian (Dialechical) IS: - conflictual, synthetic systems
- Singerian - Churchmanian IS: - involve continual learning and adaptation through feedback.

It should be noted that Singerian IS are best suited for studying all of the rest IS, although most of the MIS systems are considered from the standpoint of Leibnitian and Lockean inquiry.

4.3 Historical Review

One should realize at the outset that information was an important facet of any organization survival even before the computer arrived on the organization scene. The computer opened up new horizons for using information in support of the organization's activities. The use of the computer was an evolutionary process, where four causes can be identified as associated with this gross phenomena (Walsh, 1978)

- development of application portfolio (early 1960's)
- building of an EDP Organization (middle and late 1960's)
- building an EDP management control system (early

1970's)

- devloping a user aware-ness (middle and late 1970's)

Those four causes were paralled by four basic stages of EDP growth, as follows:

- cost reducing accounting applications (early 1960's)
- proliferation of applications in all functional areas (middle and late 1960's)
- emphasize on control (early 1970's)
- Data base applications (middle and late 1970's).

Druing Stage I of the evolution process, users found the computer to be a terrific tool in helping to reduce manpower costs, especially in areas like payroll, accounting and finance. The emphasis was on data processing.

Stage II, which came about in the late 1960's, represents the transition from data processing to MIS. To the original effort were added budgeting, forecasting, inventory control and others. The major role of the computer as a data processor started shifting. This period saw the expansion of computer facilities, with more equipment and staff added, and more sophisticated software developed, demanding budget allocations.

Stage III was a period of consolidation. The concern about MIS/EDP expenditures has grown, and the general feeling was that it was more economical to do many jobs in a few large computers at one central site than in many small computers at a number of local sites. During this stage, controls and standards were instituted and enforced.

Stage IV, is, in a way, the future state of being of the MIS/EDP systems. The user is recognized as a full partner in MIS activity known factors, which were not recognized before, are making themselves felt, such as minicomputers, data bases and distributed systems.

Most organizations, including the military system, are in Stage III. Large data centers are handling the needs of many users, where the major concern is to make the operation more efficient.

4.4 The Problem Environment

From the discussion so far, three major facts related to MIS, emerge as follows:

1. Computer based MIS grew out of data processing into information systems supporting management decision making process.
2. The decision making process varies according to the type of decision that has to be made, and this process centers around the human element.
3. In MIS, the focus was initially on procedures and instruments, and only recently shifted to the persons who utilize it.

Data processing systems are very technical in nature, MIS is much more "human." In a way, data processing is one element of MIS. Therefore, evaluating both systems cannot be performed using the same methodology. Furthermore, when evaluating those two systems, one is concerned with two different things, namely: efficiency for data processing, effectiveness for MIS. Before proceeding, a further clarification of those terms is required.

According to Keen and Morton (1978); efficiency means performing a given task as well as possible in relation to some predefined performance criterion. Effectiveness involves identifying what should be done and ensuring that the chosen criterion is the relevant one. Thus, effectiveness is setting the criterion, efficiency is comparing with the criterion. Therefore, a computer center may be very efficient in the process of generating management reports that nobody uses, i.e., the center is very efficient in pursuit of ineffective goals.

It is possible now to appreciate the problem environment of MIS. During the "data processing" period, efficiency was the proper approach. Since data processing is more technical in nature, defining the criterion, and measuring it was much easier to do. Various metrics were defined, such as reliability metrics, flexibility metrics, resource metrics, etc. (Gilb 1977). As the evolution from "data" to "information" took place, the same metrics were retained, for measuring information, i.e., the efficiency approach is used, whereas what is needed is effectiveness. Definitely, the same criteria used for data systems do not apply anymore, as MIS is more user oriented and less "technical" oriented.

What is needed is a "users" point of view to evaluate the MIS and not a "computer" point of view. After all, if a system is not used, it cannot be considered a success, even if it functions well technically.

One explanation to the current state of affairs is that historically computer scientists dealt with data processing systems, and "moved" with it to MIS, where an additional skill in management systems and behavioral sciences is required.

The MIS evaluation problem attracted management attention in recent years because of the increased investment in MIS software, that has to be justified on the basis of the benefits obtained. During the late 1950's and early 1960's, most of the investment in computers was in hardware, and only a small fraction of it went into software. Since then, the percentage that goes into MIS software has steadily increased, to the point that this has to be justified like any other investment. That prompted an increased interest in the problem of MIS software effectiveness.

5. MIS SOFTWARE EVALUATION: BASIC CONCEPTS

5.1 Introduction

This chapter serves as a prelude to the following sections of this report. Before any further discussion of MIS software effectiveness can take place, it might be worthwhile to consider some basic concepts associated with this process. Thus, the difference between data and information is first defined, leading into discussion of the difference between evaluation and measurement, which are the basic concepts required to assess effectiveness. Finally, information attributes are discussed, culminating with a management information metrics.

5.2 On Data and Information

Following Murdick and Ross (1975) definition, "information is the behavior initiating stimuli between sender and receiver. Information is in the form of signs that are coded representation of data."

Data is information if it somehow modifies the decision maker's image. Data may be considered to be some kind of recorded observations, that are not currently affecting behavior. Data <u>may</u> become information if behavior becomes affected. Thus, if a stack of reports is delivered to a decision maker and he throws up his hands in disgust, the data in the reports have not become information. Information may be defined then as "data in use", or "information is the net value obtained from the process of matching the elements of a present problem with appropriate elements of data" (McDonough, 1963). This is a very basic concept when considering MIS, since data must be delivered to decision makers as information to be acted upon. Too often MIS are treated as data systems rather than as information systems.

5.3 Evaluation and Measurement

Measurement, in its most general sense, is basically the process of ascribing a numerical value to an object or quality. Typically, it is a two stage process; the first step is setting the measuring concept - the theoretical metric, like the idea of the volt. The second step is finding a practical measuring device, like the voltmeter.

Effective use of metrics is well recognized in business and engineering. Absence of metrics can lead to lack of control over systems, and finally to failure. The fact that some system attribute has never been measured before, or cannot be measured directly or accurately, should not discourage the attempt to construct some measuring device so that certain control can be maintained over the system.

The metrical content of an attribute is a measure in a common frame of reference.

Evaluation, especially in the context of MIS, is a much broader term, as it implies value judgement, in addition to measuring. Following Keen (1975), evaluation implies the comparison between the output of the system (actual or predicted) and some criterion of success. Furthermore, success, when dealing with MIS, implies consideration of the environment in which measurements are performed.

The difference between evaluation and measurement may be looked upon also in the following way. Measurement assigns numbers, evaluation assigns value. Thus, the process of evaluation does not necessarily involve the use of numbers.

It is worthwhile at this point to review some of the problems associated with the measurement process. In the scientific world, consistency of the scale is one of the major concerns. This is even more so for measurement within an organizational environment. The comparison element, imbedded in the measurement process is also a matter of interest, as it is not certain that with the same perfect scale two different observers will find the same results. Finally, especially for measurements in an organizational context, there is the problem of the influence of the observer on the object to be measured. Those problems should be kept in mind when dealing later with measuring MIS software effectiveness.

From both scientific and convenience points of view, it is highly desirable to assign numerals to objects which are to be compared. However, in MIS, such assignment is most of the times not easy to perform. Therefore, the approach of "surrogate measures" has been developed, where, when it is difficult to assign a measure to an object or quality, another available measurement, or set of measurements is used to represent the impossible one.

5.4 Management Information Attributes

One of the objectives of this research is to assess, among other things, MIS software effectiveness techniques - implying considering a user's point of view. The basis for this kind of investigation is an understanding of the management information attributes. It should be mentioned at the outset that this is an area that requires further research. The discussion here summarizes some of the current thinking in this direction, as represented in the literature. The measurement aspects of those attributes is discussed in a latter chapter.

One of the first major works recognizing MIS within the managerial framework and defining management information attributes is that of Anthony (1965). Three levels of management are identified, as follows:

- Strategic Planning (top management)

  Policies, objectives, resources etc.

- Management Control (middle management)

  Effective and efficient utilization of resources in the accomplishment of the organization's objectives.

- Operational Control (operating management)

  Carrying out specific task effectively and efficiently

The information requirement for each management level, as perceived by Anthony, is summarized in Table 5-1, assuming that each type is a point on a continuum (Dumas,1978).

This framework has been very criticized, however, it seems that for a military environment, which this report is aiming at, it still has a lot of relevance.

Feltham (1968) defines three major attributes of information, as follows:

Table 5-1. Management Information Requirements According to Anthony

Characteristics \ level of managerial activity	Strategic Planning	Management Control	Operational Control
Focus of plans	whole business		single task
Degree of complexity	high		low
Degree of structuredness	unstructured		structured
Tempos of execution	irregular		rhythmic
Nature of information	tailor-made to the problem		tailor-made to the task
Source of information	more external		more internal
Accuracy of information	low		high
Frequency of use of information	infrequent		very frequent
Level of aggregation of info.	aggregated		detailed
Nature of communications	difficult		simple
Personalities involved	staff-type	line	supervisor
Mental activities	creative	administrative-persuasive	routine
Time horizons	long		short
Appraisal of results	difficult and long		less difficult and immediate

- Relevance: A signal is relevant if its receipt changes the decision. Therefore, relevance requires specification of both a decision maker and a decision. An ex-post viewpoint of relevance is that if a signal changed the decision, then the information provided by that signal was relevant. To be an effective decision criterion, it should be possible to apply the concept ex ante.

- Timeliness: Data do not become information until received by the decision worker.

  Two additional elements are associated with timeliness: "reporting delay" - the difference between the time of the event and the time the data is received, and "reporting interval" - referring to the storage of data and reporting it at a later date.

- Accuracy: If the same data is not produced every time the same event occurs, the relationship is expressed as probability distribution. These differences are caused by errors in recording, processing and transmitting the data. The error has two basic components: bias and variability.

  The above definition of accuracy is basically technical. However, there might be another type of error - the "information perception error" - in the case where the same data does not mean the same thing to different observers. Thus, it is not the data sent to the decision maker which is important; it is the decision maker's perception of the meaning of the data which is important.

Cohen (1971) defines five attributes (criteria) of an MIS, as follows:

- Relevance - the first and paramount attribute
- Timeliness
- Economy
- Accuracy
- Flexibility, which has a dual purpose:
  - flexibility to handle growth
  - flexibility in handling inevitable changes, both in planning and operation.

It should not be surprising that there is some overlap in the attributes suggested by various authors.

Murdick and Ross (1975, p. 357), identify the following attributes of MIS:

- Purpose: information must have purpose at the time it is transmitted to the decision maker
- Mode and format: mainly documents, verbal material or visual (CRT)
- Redundancy: the excess of information carried per unit of data. This attribute serves as a safeguard against errors in the communication process.
- Rate: rate of transmission may be represented by the time required to understand a particular situation.
- Frequency: the frequency with which information is transmitted or received affects its value, and must be related to an operational need.

- Reliability: may be expressed as the degree of confidence the decision maker places in the information.
- Validity: a measure of the degree to which the information represents what it purports to represent.

Other attributes mentioned by the same authors include:

- accuracy	- timeliness
- clarity	- availability on demand
- distribution	- selectivity of contents
- appropriateness of detail for each	- disposition method
- cost	- retention time
	- value

The Fort Hood Report (1979) has the following statement concerning the attributes of information:

> Information was considered to be one of the most critical resources in the management process. To be effective, it must be timely, accurate, and supportive of the decision making process. It should be obtained, stored, analyzed and used in as economical manner as possible.

This statement summarizes a military user observation of information attributes.

Adding a few more information attributes to the ones mentioned above, it is possible now to recap this discussion with a list of "information metrics." In doing so, it was found useful to group these metrics in the three major elements of MIS, namely:

- Management
- Information
- Systems

Table 5-2 gives this list of information metrics.

Table 5-2. Management Information Metrics

Management	Information	Systems
- Support of management decisions	- Nature of Information	- Flexibility
- User satisfaction	- Accuracy	- Adaptability
- Purpose	- Redundancy	- Complexity
- Relevance	- Reliability	- Structuredness
- Timeliness	- Rate	- Distribution
- Validity	- Selectivity of contents	- Frequency of transmission
- Frequency of use	- Clarity	- Tempos of execution
- Availability on demand	- Mode and Format	- Disposition method
- Time horizon		- Retention method time
- Level of aggregation - detail		
- Economy/Cost		

6. MIS SOFTWARE EFFECTIVENESS: ASSESSMENT OF POSSIBLE APPROACHES

6.1 Overview

As more and more organizational resources, especially within the military system, are allocated to the design and development of MIS, it becomes very important to be able to assess the effectiveness of such systems. Existence of an instrument to evaluate such systems would be very desirable, as each user could denote, using the instruments, how he viewed his MIS. It should then be possible to specify to the designers and maintainers of the MIS exactly where and how enhancements could be made. Such capability would be very desirable to the military organization, facing a dynamic information environment and unstable staffing problem.

This chapter investigates and assesses the currently available tools for evaluating MIS software effectiveness. In doing so, one should keep in mind the various comments made in Chapter 4 about the decision making process, indicating that a certain technique will have different effectiveness, depending on the organizational environment, the decision making process and the decision maker.

The following discussion borrows on a number of literature sources, especially on the one indicated in Chapter 3 as major references.

Before proceeding any further, it is worthwhile to note some comments made by Keen and Morton (1978) on the evaluation problems. Two points of view can be identified in the literature: the one focusing on Management Information Systems (MIS), and the one focusing on Information Management System (IMS). There is more than a semantic difference between the two: IMS implies much more concern with improving the operating system, usually handled by computer scientists, and ignores the management usefulness of the system, a problem better handled by management scientists and organizational theorists. Thus, when computer scientists talk about MIS, they may in reality have IMS in their mind. This prompts the drive to increase the efficiency of systems, which may or may not contribute to their effectiveness.

The difficulties associated with assessing effectiveness are summarized by Murdick and Ross (1975, p. 355).

> A clearcut method for measuring the costs and benefits of a new MIS has not yet been found.

This is even strengthened by Parden's (1978) comment that

> ... the cost effectiveness of operations systems can readily be determined, while the value of information developed in support of management decisions will always be elusive.

The discussion so far definitely points out the difficulties associated with effectiveness evaluation, however it also amplifies the importance of this issue.

As a pretext to MIS software effectiveness, it is worthwhile to gain more insight into MIS. Dumas (1978) identifies three "modes" of functioning in MIS, as follows:

- applications oriented mode
- data base mode
- informing mode

The three modes, among other features, address respectively the structured, semi-structured and less structured decision situations.

In the application-oriented mode, MIS provides data or measurements within a crystallized frame of reference among organizational partners. The data base mode performs integration of data in broader, less crystallized and more flexible frame of reference. The informing-mode MIS enables a goal seeking or task oriented decision maker to select or change frames of reference and arrive at a more personal appreciation of unstructured problem. Each mode is characterized by different scopes of requirements for data and information, different procedures, and different types of evaluation. Those features are summarized in Table 6-1.

It should be noted that the three modes are not mutually exclusive, but tend to be on a Guttman scale (i.e., informing implies data base implies applications-oriented mode).

Another aspect of MIS evaluation is the two possible "states of beings" of the system. Davis (1974) recognized the evaluation of a new or replacement system versus the evaluation of exising systems. Those two types of evaluation correspond respectively to the stage of design and operation of the system. Techniques suitable for the first stage will not necessarily be suitable for the second stage, and vice versa. Therefore, this distinction has to be made when evaluating different approaches.

The various available techniques for evaluation of MIS effectiveness can be classified according to the following major groups:

Table 6-1: Data Characteristics of the Three Modes of MIS (Dumas, 1978)

Characteristics	Applications-oriented mode	Data base mode	Informing mode
Type of inquiry	Leibnitizian & Lockean	Kantian	Hegelian
Guarantor	Internal consistency and consenusus	Integration and independence of data models.	Conflictual models
Data/information	Data = information	Data ≠ information	Data ≠ information
Meaning of data	Meaning is universal, i.e. everyone reads data according to a universal representation	Meaning is infused into data: 1. when sensing the real-world (selection and classification) 2. when structuring the data base (definition of a network of relations) 3. when handling data in a specific program (according to the model on which the program is based) The three may not be consistent	Meaning can only be assessed with respect to an individual's image and in a task environment. Meaning is experienced, not predefined
Scope of data	Routine, rhythmic, frequent (sometime realtime) detailed, numerical, historical	Application-oriented data in dis-aggregated and aggregated form; external; quantifiable; prospective.	Can only be specified by reference to individual and task environment
Source of data	Basic organizational documents recording transactions in each of four flows	Transactional documents for one part, and surveyings or samplings for another	All of other modes and the result of man coupling itself. Personal data base
Data organization	Files	Network	Network
Data handling	Specialized application-oriented chains	Ad hoc (interactive)	Ad hoc (interactive)
Value of data	Traced back to economic assess-	Economic assessment in the frame of a model, supplemented by validation of the model (judgemental)	Judgemental

- Economic Evaluation Techniques
- Noneconomic Evaluation Techniques
    - Behavioral
    - Other
- Management Science Techniques

The economic techniques include all those where a dollar value can be assigned. Management science techniques is basically the mathematical modeling approach to the evaluation problem. All the rest of the techniques were labelled "non-economic" where some of them are "semi-quantitative" in the sense that numbers can be assigned, and the rest are purely qualitative.

The various available techniques in each group are summarized in Table 6-2, which considers also the two major stages identified in MIS. This table serves as a guideline for the discussion in this chapter. First, the economic techniques are discussed, followed by the non-economic and management science techniques.

6.2 Economic Evaluation Techniques

At a first glance, the economic evaluation approach seems to be very appealing - for a couple of reasons. First, economic methods are popular, well understood and fit with other organizational practices. Second, these methods refer to evaluations expressed in monetary terms, and dollars fulfill the ideal objective of measurement on a ratio scale that allows to compare, order and compute distances among items.

However, one should realize that economic reasoning is much concerned with the optimal allocation of scarce resources, and therefore

Table 6-2. MIS Software Effectiveness Evaluation Techniques

Phase	Economic	Non-economic		Management Science
		Behavioral	Other	
Design				- Simulation - Model Building - Risk and Sensitivity
		- User's satisfaction - Manager's assessment of system value - Learning process - Decision process changes	- Volume methods - Checklist methods - Service measure - Appraisal by comparison	
Both	- Cost Benefit - Cost Saving - Capital Budgeting	- Expert Opinion - Anecdotal Evidence	- Time methods	

most of the economic evaluation will be directed towards efficiency rather than effectiveness, i.e., towards comparison between revenues and costs. Further more, in many instances, the "economics of information " is not that of allocating scarce resources i.e. a few pieces of data between users - but rather that of eliminating overabundant and irrelevant data. Economists have little concern for that aspect of information economics. Cost-benefit models of MIS evaluation compute costs as cost of information services, and the benefits are the expected desirability of the outcome - a very vauge definition. Measuring the dollar value of benefits accrued from information is a major problem as many benefits are "soft," and not eadily translatable into monetary terms.

According to Keen and Morton (1978), the whole area of "information economics" is a small and ill defined one. The problem is that of measuring information value, as this is the key to considering alternatives and trade-offs. At the present there is no satisfactory method to evaluate this value.

Bearing in mind the above comments on economic evaluation techniques, the following is a discussion of some common approaches, in spite of their limited usefulness. The ones to be discussed are cost benefit, cost saving and capital budgeting.

6.2.1 Cost Benefit. This method is a mix of economic evaluation of costs and of an attempt to convert to hard dollar terms benefits of the system, such as improved decisions, more timely information, etc. This approach does not attempt to yield maximizing decisions, but rather satisficing. Relevant costs should be defined as broadly as possible, and all benefits should be included; if it is impossible to estimate them directly, a surrogate transfer price may be generated, or a judgment can be used.

During the 1960's cost-benefit was a popular approach, however, in many cases it proved ineffectual because the intangible factors can rarely be converted to its dollar equivalent. This is even more difficult in a military environment. Sassone and Schaffer (1978, p. 44) give the following postulate: "The value of a project to an individual is equal to his willingness to pay for the project."

In a previous work by Mason and Sassone (1978), some of the information benefits that have to be measured were defined as follows:

- Data quality
- Data reliability
- Intrinsic value of information

It should be obvious how difficult it is going to be to find out, in a military system, how much one is going to be willing to "pay" for the above benefits. Even using a surrogate measure such as shadow price - the value associated with a unit of some good indicating how much some unit of performance can be increased by the use of marginal use of that commodity - is not going to be of much help in the military environment. Even the cost side of the analysis, although easier to measure than the benefits, still presents some assessment problems.

Finally, it should be recognized that the methodology for cost-benefit analysis should be different during the design phase and the operation phase. The problem during the design phase is that of defining alternatives and assessing the costs and benefits. During the operation phase the problem is that of allocating costs and measuring benefits of the selected alternative. Thus, cost-benefit analysis would be a much stronger tool for the design phase.

In summary, the following assessment can be made of this approach:

- Cost-Benefit Analysis (CBA) is a well established technique as such
- Enables explicit definition and examination of alternatives
- Measurement of benefits is difficult, especially within a military MIS
- Effectiveness is measured indrectly with dollar value
- The methodology for applying CBA in a military MIS has to be developed
- It seems that the approach is expensive and time consuming.

6.2.2 Cost Savings Approaches. Techniques in this group include two major categories:

- savings due to better decisions, and attributed - supposedly - to improved performances of the information system.
- savings internal to the information system which do-not modify the decision.

Savings of the second type (such as reduction of clerical effort) are basically efficiency measures, although it is not uncommon to see those approaches used as effectiveness measures for MIS.

Savings of the first type are theoretically very appealing, however, it is practically almost impossible to measure them. Furthermore, these cost savings do not give any control of the various attributes of information, such as timeliness, relevance, accuracy etc.

It seems that the highest appeal of those methods is their simplicity. On the other hand, their usefulness in evaluating effectiveness is very limited.

In summary, the following assessment can be presented:

- The major advantage of the cost-savings approach are its conceptual simplicity
- Its use usually emphasizes input economization rather than value of MIS
- Cost savings directly attributable to MIS are hard to estimate
- For use in military systems, non dollar savings are oftentime more important.
- Many important information attributes are not controlled.

6.2.3. Capital Budgeting Methods. Those methods could be regarded as an extension of the cost savings approach discussed previously. In a way, the capital budgeting methods are the tools to perform the proper economic analysis on the cash flows generated by the savings methods. In this category one could include discounted cash flow method, pay back period, break even analysis, internal rate of return etc. The techniques per se are well developed and recognized, however, their use is dependent on being able to generate the proper cash flows, and that's where the major problem is.

6.3. Non-Economic Evaluation Techniques: Behavioral

Given the various shortcomings of the economic evaluation methods in the context of MIS, it is only natural that attention has been focused on non-economic approaches. This section will discuss behavioral techniques, whereas the next one handles other techniques.

Noneconomic methods are in general more empirical. Their present state of the art is less developed than that of the economic approaches. The rationale for using non-economic methods is that they can allow accounting for other benefits that can not be considered in the economic evaluation approaches. Furthermore, these methods are in general better in evaluating the operation stage of MIS. Their main advantage is that, if a user's point of view is to be taken in evaluating MIS effectiveness (as is done in this research) then the noneconomic methods, especially the behavioral, are user's oriented in nature. It has been shown that paying attention only to "computer" issues is not nearly enough for success of information systems in an organization (Keen and Morton, 1978, p. 50).

The major criticism leveled at the behavioral methods is their lack of objectivity. However, objectivity is not always a valid concept when dealing with socio-technical systems such as MIS.

In the balance of this section, six different behavioral techniques are discussed, as follows: user's satisfaction, manager's assessment of the system's value, the decision maker learning process, decision process changes, expert opinion, anecdotal evidence.

6.3.1. User's Satisfaction. This is possibly the most important single parameter of MIS that is to be measured. The importance of this parameter stems from the fact that it represents some integration of all the information attributes, as perceived by the user. User's satisfaction can be measured through some form of psycho-social inquiry, or attitude rating.

One of the problems of evaluating user's attitude is the variability of this attitude from user to user, and for the same user for different circumstances and time.

Some recent research in this area will first be cited. Walther (1973) recognized the problem mentioned above and defined the concept of "flexibility," which is the "capability of the system being changed by the user in order to make it responsive and adaptable to ever-changing user needs and preferences." He also recognized that flexibility is not uniformly good for everyone. The major contribution of this research is showing that semantic-differential scales are feasible for evaluation of user attitudes.

Semantic-differential has been used also by Gallagher (1974), who found it a useful tool for measuring and analyzing the qualitative value of MIS. Some of his other findings are of interest too:

- A reasonable estimate of the monetary value of a specific management information can be determined by asking each user to estimate the system's value to himself.

- Image state is <u>not</u> reliable measure of the nonmonetary value of MIS.

Seward (1973) devised and tested a questionnaire using Likert scales, and concluded that "measuring user satisfation with the proposed information system is a feasible substitute for measuring information system effectiveness."

The above examples are representative of current approaches, as reported in the literature, to measuring satisfaction. As much as it looks promising, there are certain drawbacks. All those approaches are relatively recent, and have not yielded much enthusiasm from practitioners. All use the techniques of questionnaires which time and again are criticized. To overcome this difficulty, unobtrusive techniques have been tried, such as automatic recording of the characteristics of users (Kitous, 1976). Again, those methods were never tried in a large scale system.

To recap, there are not many instances of systematic use of psycho-social techniques for evaluating computer application performance. Yet, user's opinions are a valid surrogate for measuring MIS effectiveness. However, the methodology for pshyco-social inquiry is far from being established, to the point that it is hard to say whether scientific knowledge is attainable in this field. Even if an agreed upon method were available, there are still practical difficulties of implementation, such as high cost and lack of skilled personnel.

In summary, the assessment of this approach is:

- The general concept is very appealing, as user's satisfaction could give one overall measure of MIS software effectiveness.

- The basic methodology for this approach has mot matured yet. It seems that no large scale MIS has been studied using this methodology.
- Costly and time consuming (for interviewers and interviewees)
- Risk of bias due to the behavioral impact of the approach, besides the familiar bias due to sample size and representativeness.
- Difficult to conduct on a periodic basis.

6.3.2 Manager's Assessment of the System's Value. Asking manager's is one effective way of defining the system's value. Their perceptions can be gathered at regular intervals, using questionnaires or structured interviews. One such attempt is reported by Swanson (1974). He used questionnaires, and measured user's appreciation by averaging user's evluations of the information they received and the means by which the information was provided. The result was an index of appreciation. The study was performed in a real world situation, however, it was directed at a specific information system and therefore could not be generalized.

This approach can be viewed as a subset of the previous one, thus the same comments apply here too.

6.3.3 The Decision Maker Learning Process. This approach utilizes research done in cognitive processes and applies it to MIS. It is an attempt to evaluate the human information processing and learning and use it as an indirect measure of MIS effectiveness. This method requires the use of simple diagnostic techniques for capturing the decision maker's concepts and learning. However, at present, the use of such techniques in the real world is close to zero (Keen and Morton, 1978, p. 219). Measuring this cognitive process can be attempted by using questionnaires, requiring that a "before" and "after" condition be established. Even if the process of learning can be measured, it is hard to place a value on, as the training and tools for it are deficient.

It is obvious that this tool could be adequate for the operation phase of MIS. However, a lot of behavioral research has to be performed in developing the tool per se.

6.3.4 Decision Process Changes. In this approach, the outcome of the decision is secondary, and the element of interest is the changes in the decision process, where the implication is that better decisions will be made if the decision making process is improved. Again, this approach too is suitable for the operation phase of MIS.

This method requires two problems to be resolved before it can be implemented:

- definition of a "better" decision process
- measuring the process changes

Overcoming the first problem requires a normative model that defines a "better" decision process. The measurement problem is a more "knotty" one. An attempt to tackle this problem is reported by Stabell (1974) and Ginzberg (1975), who used "traces" to measure changes in the decision process. A trace is a record of interaction between the decision maker and the MIS. Those traces are easy to record when the interaction is done through a terminal. However, one should not try to implement them without informing the users, as they represent some sort of surveillance.

Traces are one of the more powerful methodologies developed so far that provide insight to the qualitative aspects of the decision making process. One should realize, however, that traces are not a mere count, and requires further analysis.

6.3.5 Expert Opinion. This is a typical approach-use of a reference group-to evaluate situations where standards of desirability are ambiguous. The leading technique in this category is the Delphi method. Ligon (1978) reports the use of this method in the context of MIS, in order to identify the ingredients of a successful system.

The Delphi methodology as such is well developed, however, its application in MIS is relatively new, and requires more development. Furthermore, utilization of Delphi within a military system should be approached very cautiously.

6.3.6 Anecdotal Evidence. This is a method that is intended to supplement formal evaluation by collecting anecdotal evidence such as insights, examples, lessons learned, opinions and events collected by a trusted, neutral, skilled observer. Quantifying the results is next to impossible in this approach, and the outcome depends heavily on the observer.

6.4 Noneconomic Evaluation Techniques: Other

This group includes a number of techniques, most of them might be labeled "quantitative" in the sense that they contain numbers, however, they are noneconomic in nature. Those techniques that contain numbers mainly use the basic approach of mere count of physical items, and can be summarized in three types: volume, time and checklist. Additional methods discussed in this section include service measure and appraisal by comparison.

6.4.1 Time Methods. Time is one of the few elements that are easy to measure and understand, and it may be an attribute of the information system or information itself. Also, time may represent a measure of efficiency or effectiveness. Thus, evaluating MIS software by the number of reports processed per unit of time is definitely a measure of efficiency, not effectiveness. However, timeliness is one of the important attributes of information that contributes to MIS effectiveness.

Timeliness can be measured in terms of the difference between the time required by the decision maker and the actual time when the information is provided by the MIS. This difference may be negative (information delay) or positive. This delay can be a design parameter for MIS, or a monitoring element during operation.

Although easy to measure, it is difficult to state cause-effect relationship between more timely information and better decisions.

6.4.2 Volume Methods. Most of the volume measurements - such as inputs and outputs - definitely relate to measuring efficiency rather than effectiveness, in many cases that of the hardware system. However, there are instances where volume is used for evaluating the effectiveness of MIS. This is considered in a research reported by Goldberg (1973), Kennedy and Mahaparta (1975) and Kitous (1976), where the effectiveness of MIS was evaluated by counting how many times a given report, or a piece of information is used by the decision maker, or how often items in the data base are accessed, or how important is the ratio of useful information to noise.

Since volumes may measure the functioning of the system under different conditions, they should be presented as statistical data and not as absolute data.

The volume approach is definitely an MIS operation phase approach. It has the advantage of being easy to measure and understand. On the other hand, the correlation between, say high volume of report use and high effectiveness of information does not always hold true, as the high usage might be simply due to the lack of any other tool, and not necessarily due to the MIS effectiveness.

6.4.3 Checklist Methods. All in all, a relatively weak approach, that fits most structured decision environment. The method is composed of a list of criteria and a measure of its achievement, such as cost control achievements, number of personnel trained, number of reruns, etc. These criteria can be placed in a historical perspective showing trends.

6.4.4 Service Measure. This approach is suggested by Keen and Morton (1978), and is composed of the following elements:

- responsiveness of the system
- availability and convenience of access
- reliability
- quality of system support, such as documentation and training

Those attributes could be very helpful in monitoring MIS. However, the authors give no clue as to how to perform the measurement of those elements.

6.4.5 Appraisal by Comparison. This approach is ill defined, very little recognized in the literature, and is composed of comparing the performance observed with the performance in similar organization. There is no rigorous methodology behind this approach, especially for MIS, and it might be looked upon more as a concept rather than as a method.

6.5 Management Science Evaluation Techniques

This group of methods is mainly beneficial during the design phase of MIS. Management Science techniques imply some sort of mathematical model building manipulated through optimization, simulation or heuristics. Typically, the model includes some of the MIS objectives as related to the total organization. The major shortcomings of this approach are:

- orientation towards economic data analysis, with all the limitations encountered in MIS
- hard to understand by managers
- based upon assumptions, which are often erroneous, due to the difficulty of the socio environment of MIS.
- validation of results is often time hypothetical, as models are seldom tested in a real setting.

In spite of the above difficulties management science approach may have some merits in certain cases. Three approaches will be surveyed: simulation, model building and risk analysis and sensitivity analysis.

6.5.1 Simulation. Two major types of simulation models exist: for hardware evaluation, and for computer systems application evaluation. In the context of the present discussion, only the second type is of interest, as it engulfs the evaluations of the computer and of its decision making environment. This approach was first launched by Bonini (1963) who proposed to relate organizational behavior and informational factors to the economic variables in the firm. Thus, some simulation models possess many of the shortcomings of economic evaluations.

Boyd and Krasnow (1963), constructed a simulation model which basically evaluated the timeliness of information. Kriebel (1969) used simulation models to evaluate the joint MIS - decision system. Courbun (1976) followed this approach in the area of production information systems and developed a simulator (MISSIM).

Other applications of simulation can be found in the literature, and the field of application is varied. As much as it looks appealing, MIS simulation seems not to have left the research environment on into the real world. Most reports come from researchers, especially doctoral students. Probably one of the major problems in real world applications is that the input data is not readily available, costly and unreliable. Furthermore, simulation requires some measurement on a real system with statistical significance - a costly proposition sometimes.

In summary, MIS simulation is a sound concept that requires further development if an attempt is to be made to use this approach in the context of military MIS.

6.5.2 Model Building. For the completeness of the discussion here, it is worthwhile to review an example of structuring a mathematical model of MIS. The example presented here is taken from Kennedy and Mahapatra (1975).

Notations:

Suppose there are "m" number of factors given by $f_1,\ldots,f_m$(or pieces of information or data) that are affecting all the decisions of the organization.

Suppose there are "n" number of decisions given by $D_1,\ldots,D_u$ made in each department or organizational subunit.

Suppose there are "r" number of organizational subunits or departments in the system given by $d_1,\ldots,d_r$.

Then in general f_{ijk} denotes, information element "i" affects (or is needed for) decision "j" in department "k" where

$$i = 1,\ldots,m$$

$$j = 1,\ldots,n$$

$$k = 1,\ldots,r$$

Let "σ_{jk}" represent the frequency of decision "j" in department "k."
Let "α_{ijk}" be the importance (rank) of factor "i" in decision "j" in department "k."
Let "β_{jk}" be the importance (rank) of decision "j" in department "k."
Let "γ_k" be the importance (rank) of department "k" in the system.
Then the importance (rank) of factor "f_{ijk}" for decision "j" in department "k"

$$= \tilde{\alpha}_{ijk}(\widetilde{\beta\sigma})_{jk} \qquad \gamma_k = \Omega_{ijk}$$

where

$$\tilde{\alpha}_{ijk} = \alpha_{ijk}/\sum_i \alpha_{ijk}$$

and

$$(\widetilde{\beta\sigma})_{jk} = \beta_{jk}\sigma_{jk}/\sum \beta_{jk}\sigma_{jk}$$

Therefore, the importance (rank) of the information element "f_i" in the total system

$$= \sum_{k=1}^{F} \sum_{j=1}^{u} \left(\tilde{\alpha}_{ijk} \cdot (\widetilde{\beta\sigma})_{jk} \cdot \gamma_k\right)$$

$$= \sum_{k=1}^{r} \sum_{j=1}^{u} \Omega_{ijk}$$

$= \mu_i$ (say) $\quad i=1,\ldots,m$

From the preceding equations, it is apparent that $\sum\mu_i$, the total importance of all information elements summed, must equal unity times the number of departments. From this it follows that each μ_i is a measures of relative importance. Also, the sum of the values of those information elements now provided can easily be interpreted in terms of efficiency in meeting total (ideal) information needs.

Thus, the process allows us to arrive at the importance index (μ_i) of all (information) factors that need be kept in the MIS. Depending on the budgetary constraints and the computed ranks of all the information elements, the inclusion or exclusion from the data base of MIS may be determined.

At best, it can be said that if an optimization model can be formulated it will evaluate a very narrow segment of MIS.

6.5.3 Risk and Sensitivity Analysis. Should be looked upon as a supplementing approach to simulation or optimization.

Sensitivity is an attempt to identify critical variables recognizing the fuzziness of MIS environment, or low reliability of data, or the simplifying hypotheses underlying the model.

Risk tries to quantify identified weaknesses of the system, such as risks of delays, errors and underestimation of costs, or uncertainty of environment.

This is more of a general concept. Specific application have to be "tailor made" according to the type of MIS and environment.

A summary of the various techniques and their relation to information metrics is discussed in the following chapter:

7. MANAGEMENT INFORMATION METRICS AND EVALUATION TECHNIQUES

The discussion so far concentrated on defining and assessing the various available evaluation techniques for MIS software effectiveness. However, one dimension is still missing, namely, the extent to which available techniques can evaluate management information attributes. This chapter performs such analysis.

In order to proceed, it is worthwhile to do some additional grouping of the attributes shown in Table 5-3. This grouping is shown in Table 7-1.

Table 7-1. Management Information Metrics - Regrouping

Management	Information	Systems
I: <u>Decision Making</u>	I: <u>Content</u>	I: <u>Structure</u>
- support of mgt. decisions - user satisfaction - purpose - relevance - validity - level of aggregation detail	- nature of information - accuracy - redundancy - reliability	- flexibility - adaptability - complexity - structuredness
II: <u>Time</u>	II: <u>Presentation</u>	II: <u>Speed</u>
- timeliness - frequency of use - availability on demand - time horizon	- selectivity of contents - clarity - mode and format	- frequency of transmission - tempos of execution
III: <u>Economy</u>	III: <u>Rate</u>	III: <u>Distribution</u>
- economy/cost	- rate	- disposition method - retention time

Thus, the grouping of the management information metics can be summarized as follows:

Table 7-2. Grouping Summary

Group	Management	Information	Systems
I	Decision Making	Content	Structure
II	Time	Presentation	Speed
III	Economy	Rate	Distribution

Some general observations concerning the above grouping are in order. One interesting approach is to examine the above attributes from the point of view of the type of evaluation technique required, namely: subjective - where a high element of judgement (i.e., behavioral) is required, or objective - where more direct measurement is applicable. This is done in Table 7-3 where another group was added - mixed evaluation, when direct measurement and judgement are required.

Table 7-3. Type of Evaluation Required
(S - subjective, O- Objective,
M - Mixed)

Group	Management	Information	Systems
I	S	O	M
II	O	M	O
III	M	O	O

The point of departure for this research was taking a user's point of view to evaluate MIS software effectiveness. This immediately creates the image of a more subjective evaluation approach. What emerges from the above analysis is that only one group of management information attributes - as important as it is-requires a pure behavioral approach, whereas the rest of them need a mixed or pure objective approach. The importance of this observation is that the behavioral approaches are deficient because of immature methodologies (sometimes labeled "soft" or "weak" techniques), where for objective evaluations more rigorous techniques can be used or developed.

Further insight can now be obtained by examining the management information metrics coverage achieved by the various techniques presented in this chapter. This is done in Table 7-4, which also summarizes the discussion in this chapter. For indicating the level of coverage of a group of attributes by a technique, a scale of three numbers was used, representing the following:

1 - Primary applicability of the technique to measuring the attribute

2 - Secondary relation to the attribute

3 - Weak relation to the attribute.

Some comments about Table 7-4 will enhance its understanding. The entry to the table is through the "Evaluation Technique" column. The right hand side of the table ranks each technique in terms of its applicability to measuring the specific metric group. The left hand side indicates the MIS phase in which the technique is applicable, and also assesses the major advantages and disadvantages of each evaluation technique. In reviewing this table, one should inspect both sides. Thus, for example, user's satisfaction is identified as very applicable to measuring decision making attributes

Table 7-4 Management Information Metrics and Evaluation Techniques

Methods							Metrics								
Assessment		MIS Phase			Evaluation Technique		Management			Information			System		
Advantage	Disadvantage	Design	Operation	Both			Decision Making	Time	Economy	Content	Presentation	Rate	Structure	Speed	Distribution
General methodology well established	Hard to quantify benefits. Needs further development for mil. MIS. Expensive/time consuming.			X	Cost Benefit	Economic	3		1	3			3		
Simple	Cost savings directly attributable to MIS are hard to estimate.			X	Cost Saving	Economic			1						
Well established methodology	Hard to generate cash flows.			X	Capital Budgeting	Economic			1						
A rather comprehensive measure	Basic methodology has not matured. Biased, costly and time consuming.		X		Satisfaction	Behavioral	1	3		3					
"	"		X		Value Assessment	Behavioral	1		3						
Measures decision making process improvement	Methodology of measuring cognitive processes is lacking.		X		Learning	Behavioral	2								
"	Measurement possible in limited cases.		X		Process Change	Behavioral	1								
Requires little effort	Vague methodology.			X	Opinion/ Anecdotal	Behavioral	2								
Simple	Limited; difficult to show cause/effect relationship.			X	Time	Other		1							
"	"		X		Volume	Other		2		2		1		1	
"	Limited		X		Checklist	Other		1						1	2
Very appealing	Ill defined. No methodology.		X		Service Measure	Other				1	1	1			
	Ill defined. No methodology.		X		Comparison	Other		1							
Well established methodology	Limited; orientation towards economic data	X			Management Science	Mgt. Sci.		2	1						

(Table 7-1). However, because of the weakness of the basic evaluation methodology, the net result is inadequate evaluation of the attribute.

The emerging picture from Table 7-4 is that the field of evaluating MIS software effectiveness - a user's point of view although having many shortcomings, seems to be in a better shape than represented often times in the literature by comments such as: "A clear cut method for measuring the benefits of MIS has not yet been found" (Murdick and Ross, 1975).

Specifically, it seems that the "decision making" group of attributes received more attention than the "information" and "system" groups, although without very much success. On the other hand, the "information" and "system" groups have a potential for better results because of the nature of the measurement techniques required - less reliance on behavioral science techniques and more reliance on objective approaches (Table 7-3).

8. MIS SOFTWARE EFFECTIVENESS: WHERE DO WE GO FROM HERE?

8.1 Introduction

In order to be able to assess research needs in MIS software effectiveness, it is not sufficient to establish the "state of the art" of the current approaches, but other elements affecting those needs have to be examined. Specifically, the issues of requirement planning, future trends, centralization versus decentralization of computer facilities and the MIS design process are going to be discussed.

8.1 Requirement Planning

The purpose of the discussion here is not to make a thorough analysis of this process, but rather describe a few aspects of requirement planning and point their importance to the MIS evaluation process.

Requirement planning or need identification is a crucial element in MIS design, however, it is also as important for the evaluation process, since a clear statement of needs can facilitate measurement of their fulfilment ex ante. It is one of the most important, yet one of the most difficult areas of MIS, since requirements, like beauty, are often times in the eye of the beholder. Even more so when a few decision makers, performing the same managerial function, are asked to identify their needs.

The type of needs a decision maker has at various times and for various purposes depends largely upon the personal attributes and the organizational environment in which decisions are made (Murdick and Ross, 1975).

Personal attributes influence the needs definition through three elements:

- Knowledge of information systems - The more the decision maker knows about computer based systems, the more sophisticated and specific his needs are going to be.
- Decision making style - affects the kind and amount of information required. Here comes to bear the various "inquiring systems" as defined in Chapter 4.
- Perception of information needs - one common problem is that many decision makers are ignorant of the type of information they need.

Organizational environment interacts with the needs definition as follows:

- Nature of the organization - the larger, more complex organizations require more formal information systems, which are critical to their operations.
- Level of management - in Chapter 5 the various information needs of the three management levels (Anthony, 1965) were defined. Each level needs different types of information, in different form, different amount of detail and different frequency. Furthermore, decision makers at all levels have different information needs.
- Structure of the organization - the more highly structured the organization, the easier it is to define information needs. This, in a way, should make the requirement planning

process easier within a military organization.

A systematic approach to requirement planning is important in any organization, a military organization thus included. One excellent example of identifying needs within the Army system - at the installation management level - is given in the Fort Hood IMS report (March, 1979). The method used there, to identify needs and other parameters of the system, is a "Four Quadrant Matrix," schematically presented in Figure 8-1.

<table>
<tr><td>QUADRANT I

Who are the key decision makers for each function/subfunction within the organization</td><td>ORGANIZATIONS</td><td>QUADRANT II

Who uses output and provides input to existing systems?</td></tr>
<tr><td colspan="2">FUNCTIONS AND SUBFUNCTIONS</td><td>DATA SYSTEMS</td></tr>
<tr><td>QUADRANT IV

How is efficiency of function performance measured</td><td>METHODS OF MEASURING EFFICIENCY</td><td>QUADRANT III

Which data systems provide information needed to measure performance</td></tr>
</table>

Figure 8.1. Four Quadrant Matrix

A detailed procedure for defining information requirements is given in King and Clealand (1975)

8.3 Future Trends

It is difficult to project the future of computer based MIS, however, certain trends in certain elements of this system can be identified, and could be summarized as follows (Murdick and Ross, 1975):

- The changing nature of MIS
- Real time and time sharing
- Information Technology
- The people problem

8.3.1 The Changing Nature of MIS. The shift away from hardware and office automation into improved system design for managerial use will continue, where the objective will be *improved* systems for management applications.

8.3.2 Real time and time sharing. Despite the debate whether management requires real time capabilities, use of real time is going to accelerate, mainly because the improvement in computer communications system. This will enable accessing data bases, model building and query. Systems will become much more commonplace, moving in the direction of decision support systems (DSS). The improvement in computer communications systems will also impinge on the tendency to use centralized data bases via time sharing.

8.3.3 Information Technology. Some improvement in hardware technology and use are going to take place, in the following elements:

- data communication
- data storage technology
- man machine interface, where improved direct interrogation of the computer is going to be achieved
- input/output devices, which are the current bottleneck, will be improved by use of remote terminals, optical data recognition, voice input, automatic copying equipment, and computerized indexing systems.
- EDP technology will be merged with telecommunications technology.
- Further development of minicomputers will enable their utilization in one of three modes:
  - "Stand alone" applications
  - "Front end system"
  - Data concentrators

However, apparently the biggest impact is going to come from three technologies that are going to merge into what might be labeled "Information Processing." These three technologies are currently known as:

- distributed systems
- data base systems
- word processing

Distributed systems make use of teleprocessing and miniaturization of computers (minis and micros). Data base systems make use of high density direct access storage devices, and word processing depends heavily on miniaturization of computers and direct access storage as well as relatively inexpensive terminal devices. These technologies are an outgrowth of existing technologies.

Of particular importance to MIS is the impact of distributed systems, as discussed later.

8.3.4 The People Problem. The pace at which future developments occur will depend on management's response to these trends. For properly coping with those trends, training and educaiton of people, both within the organization and outside, is probably the best answer.

8.4 Centralization versus Decentralization and Distributed Systems

The issue of centralization is a classical issue in the study of organizations, and MIS has not avoided this issue too. Putting it in the context of the various "inquiry systems" defined in Chapter 4, a Leibnitian inquirer, leaning towards logic and internal consistency, would probably require a centralized information system. A Hegelian inquirer, leaning towards conflicting representations, would probably require some form of decentralization.

On a less philosophical level, economies of scale have induced a thrust towards centralized data processing in the sixties and early seventies. However, due to the recent and postulated technological developments, economies of scale are no longer a major issue, since the economics of large systems versus multiple small systems is balanced. On the other hand, decentralization enhances better acceptance of computers and improved service to the user due to closer control.

According to Davis (1974) six main strategies can be considered to combine centralization and decentralization of information processing systems:

1. Central control of all EDP functions.
2. Central advisory function with all the information processing development and operations remaining in the sub units.
3. Central control of hardware and software operations with decentralized system development and programming.
4. Central control of all EDP hardware, operations and programming, with only systems development being decentralized.
5. Central control of planning, analysis and programming with decentralization of hardware.
6. Distributed computing with both hardware and software partly centralized and partly decentralized.

Basically, today, the centralization-decentralization problem is more a political issue rather than a technological problem. A compromise, responding to both issues, is emerging today under the heading of "Distributed Systems." The technical elements of this approach were defined in the previous section, and it might be worthwhile to examine some of its organizational aspects.

The term "distributed systems" may mean different things to different people. To some, the term implies distributed files or data bases, to others, distributed CPUs, and both still to others. Following Walsh (1978), the following distinction is made:

- Distributed processing describes an orderly fragmentation of processing among two or more computers with the processing controlled by a centrally located computer commonly known as a host.
- Distributed data bases indicates an orderly fragmentation of data bases or files among the peripheral storage devices of one or more computer configurations
- Distributed systems describes the hardware and/or software configuration of a system in which distribution processing takes place.

Thus, distributed systems represent technology's contribution towards resolving the old "centralization versus decentralization" issue. It is this kind of system that enables implementation of any type of the six centralization/decentralization strategies described above. As such, distributed systems is a contemporary phenomenon that seems to be here to stay.

8.5 MIS Design Process: Comments

The importance of requirement planning for the MIS design process was emphasized already in Section 8.2 The design process affects both MIS effectiveness and its evaluation, especially in the sense of embedding, during the design, evaluation components in the system. Following therefore, are some comments related to the design process.

Effective system design cannot take place in a managerial vacuum, therefore, management interest, involvement and support is required at all levels. Specifically, it is important to ascertain that the following elements exist:

- User's participation - not only in defining the requirements, but in the design process itself
- Top management support
- Insure that the designed system maintains the information attributes. Thus, for example, if attributes such as timeliness, relevance, flexibility etc. are missing, the chances of this MIS being effective are minimal.

Especially important as part of the MIS design process is to design a "maintenance" capability, that could perform, once the system is in operation, a function of product enhancement (providing new functional capabilities), product improvement (i.e., increasing its reliability or supportability) and the correcting of anomalous behavior due to design oversights.

One consequence if this aspect of MIS is that the system is usually at some level of continuing development; therefore, it appears to be never completed to any observer who believes the <u>myth</u> that turnkey MIS can be produced.

The stage is set now to identify research needs, which is done in the next chapter.

9. RESEARCH NEEDS

It is possible now, based upon the discussion throughout this research, to identify research needs in the general area of MIS software effectiveness. The research needs were classified in three groups, as follows:

- Evaluation Methodology
- Military MIS
- Impact of future trends

9.1 Evaluation Methodology

In Chapter 6, a thorough analysis of the "state of the art" of evaluation techniques was performed, and summarized in Table 7-4, in relation to the management information metrics that was developed in Chapter 4. The general conclusion that can be drawn is that there is no one satisfactory approach that can measure and evaluate MIS software effectiveness from the user's

Recalling the two stage process of evaluation and measurement discussed in 5.3, this state of affairs can be attributed to two problems:

- deficiencies in establishing the theoretical metric (the "volt")
- shortcomings of the measuring devices (the "voltmeter")

It should also be clear, like in many other instances, that there can be no single value that could assess the MIS effectiveness. Even if general attributes like "user satisfaction" or "relevance" could be measured without any ambiguity, they still do not cover all aspects of effectiveness.

Those general observations have to be broken down into their components in order to identify more specific research areas. Those specific areas are presented now.

9.1.1 Techniques Research. In Table 7-4, the extent to which available techniques can evaluate management information attributes was displayed. Additional information can be extracted from this table by performing the following analysis: the various techniques were lumped together into their major four groups - economic, behavioral, other and management science. Also, the various attributes were lumped together into the three major groups - management, information and system. Now, a count has been made of the number of possible applications of a certain technique group to a certain attribute group, regardless of the ranking of this application or the quality of the technique. The resulting matrix is shown in Table 9-1.

Table 9-1 Count of Evaluation Techniques Applications

	Mgt.	Inf.	Sys.
Economic	4	1	1
Behavioral	7	1	-
Other	3	5	3
Mgt. Science	2	-	-

It is obvious that the most attention, by implication, has been given to the "management" group of metrics, and not surprisingly so, however, without too much success, as most of those techniques are of the behavioral type that was already identified as being deficient. On the other hand, the other two groups will require either the objective or mixed evaluation approach (Table 7-3), possibly cheaper techniques which should be much simpler and less problematic in their application. However, those two groups received less attention. The appealing research needs emerging from this analysis are as follows:

- expansion and development of the measurement and evaluation techniques for the "information" and "system" group of attributes, emphasizing objectivity of measurement and low cost.
- research into the possibility of using the above groups of attributes as a "surrogate" measure to evaluate the management group of attributes, especially those that require a pure behavioral approach. Should this be possible, then the attributes of the "management" group could be evaluated by a cheaper and simpler method, thus avoiding the problems of the behavioral techniques, which apparently will not disappear anytime soon.

9.1.2 Management Information Dimensionality. It was pointed out before, that there can be no single value that will measure MIS effectiveness. Due to the multi dimensional nature of the management information metrics, evaluating effectiveness becomes to be a complicated issue. Suppose, for example, that a numerical value could be assigned to each one of the attributes. The basic evaluation issue is not resolved, as measuring each attribute does not say a thing yet about the effectiveness of the system. This points out the following specific research needs:

- setting standards for "good" values of attribute measurement (those standards may vary from system to system)
- methodology for evaluating the effectiveness of the system based upon measurement of the attributes. This amounts to giving the system effectiveness meaning based upon measuring the elements, where some values are "good," and some "bad." An analogy from a different field: Volt and ampere are measurements of attributes. Watt is an evaluation of effectiveness.

9.1.3 Impact of the Decision Environment. In previous chapters, different aspects of the decision environment were discussed, such as: different types of decision making processes, different types of decisions according to the organizational hierarchy (i.e., strategic, tactical, operational), different contents of decisions (i.e., planning, staffing, controlling, etc.) - in short, a varied decision environment. It seems reasonable then that effectiveness evaluation should consider the decision environment. This suggests the following research issue:

- Evaluating MIS effectiveness for different organizational levels, say three: Top, middle and operations management.

9.1.4 Design Phase Evaluation. By and large, it can be seen from Table 7-4 that the effectiveness evaluation during the operation phase is better covered than that during the design phase. The importance of effectiveness evaluation during the design phase stems from two reasons:

- investment justification
- assessment of the system effectiveness after implementation

Typically, the economic approaches seem to hold the highest "hope" for this phase, however, it was pointed out that potential savings or benefits are hard to measure, and apparently, further progress in this direction is going to be difficult. New approaches should be tried - specifically, the following research is suggested:

- use of simulation for design phase evaluation
- use of real world experiment, i.e. a pilot project.

9.1.5 Methodology for Continuous Review and Evaluation. MIS "operates" within a dynamic environment, where often times both the nature of the operation and the decision maker are changing. This implies that effectiveness may not be, once established, a constant feature of the system. Furthermore, a drop in effectiveness may require some "maintenance" activities. All this points out that a methodology for continuous evaluation has to be developed. It seems that the continuous evaluation is going to be less comprehensive - in terms of attribute coverage - than the "discrete" evaluation, and have the following feature.

- low cost and not time consuming
- composed of user feedback and objective measurement, preferably automated (such as volume measurement etc. - note the idea of traces in Chapter 6.)

9.2 Military MIS

The research needs included in this section imply that the specific flavor of a military system should be taken into account.

9.2.1 Requirement Planning. Requirement planning is a recognized process today, and was identified as one of the key elements in MIS design and am important element in MIS evaluation. The existing approaches need some development, and research is required in two areas

- a methodology for a "system wide" requirement planning, where the needs identified are used to assess the MIS effectiveness during the design phase.
- means of measuring the needs fulfillment during the operation phase, as a measure of the system effectiveness.

9.2.2 Management Information Attributes Ranking. The management information metrics developed includes a high number of attributes, some probably more important, some less for a specific system.

This points out to a research need for ranking the attributes, serving two goals:

- possible weighting of the attributes for effectiveness evaluation
- where measurement methods do not exist, then the ranking will identify those attributes for which the research effort should be directed first.

9.3 Impact of Future Trends

Future trends may impact the effectiveness issue in two ways:

- change the effectiveness of MIS by "scoring" a higher values on some of the attributes measured.
- enable better measurement of some information attributes

Specific research needs in this area are:

- distributed systems
- interactive systems

In both cases, the specific issues to be investigated relate to the comments made above, namely:

- possible increase in MIS effectiveness due to use of those systems
- embedding of measurement tools in the system itself.

9.4 Research Clusters

The research needs identified were defined as separate issues. However, there are research topics more related to each other than others. Thus, a grouping of related topics has been done, yielding "research clusters," as follows:

Measurement Cluster

- Expansion and development of the measurement and evaluation techniques for the "information" and "system" group of attributes
- Use of "infomration" and "system" group of attributes as a surrogate measure for evaluating the "management" group
- Setting standards for attribute measurements
- Attribute ranking

Effectiveness Cluster

- Methodology for evaluating the effectiveness of the system based upon measuring the attributes
- Evaluation of effectiveness for different organizational levels.
- Methodology for "system wide" requirement planning, where the needs identified are used to evaluate effectiveness
- means of measuring need fulfillment as an indication of effectiveness.

Design Phase Cluster

- Use of simulation for design phase evaluation
- Use of real word experiments - a pilot project

Future Trends Cluster

- Methodology for continuous review and evaluation

- Distributed systems and effectiveness
- Interactive systems and effectiveness

10. CONCLUSIONS AND RECOMMENDATIONS: MIS EFFECTIVENESS PROJECT - GENERAL GUIDELINES

Now that the various research needs have been identified, it is possible to suggest the approach for an MIS effectiveness project within the Army system. The approach proposed has a modular structure, based upon the four research clusters defined in the previous chapter.

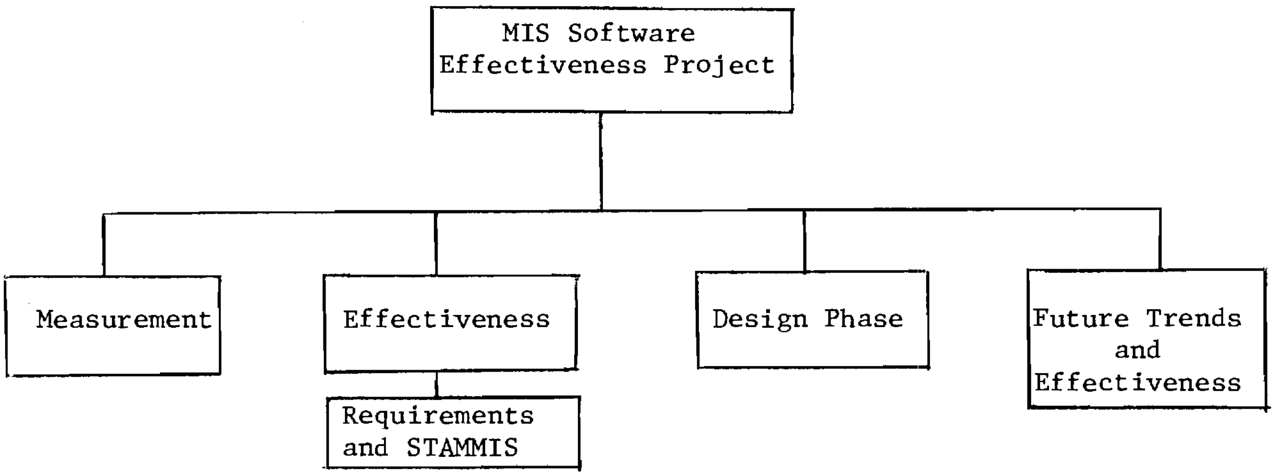

Figure 10-1: Modules of MIS Software Effectiveness Project

Thus, the four modules are:

- Measurement module
- Effectiveness module
- Design phase module
- Future trends and effectiveness module

The modular approach gives the flexibility of performing the whole project or working on each module separately. It also enables splitting the project between different researchers and geographical locations. <u>If a sequential approach is to be used, it is recommended</u>

that the modules be implemented in the sequences presented, i.e. from left to right.

The basic contents of each module was described in Chapter 9. Some additional comments are added here.

10.1 Measurement Module

This module contains four major research areas, briefly summarized as:

- measurement techniques
- surrogate measures
- standards
- attribute ranking

Probably the area to start with is attribute ranking. Standards can be based upon the "service level" desired, historical records if available, and could serve as a monitoring tool too. Investigation of the possibility of surrogate measures is apparently the most difficult research task in this module, and probably the most important.

10.2 Effectiveness Module

This module is basically concerned with the "heart" of the effectiveness issue, i.e., research into evaluation of effectiveness, once measurements are available. Definitely, part of the activities in this module depend on the results obtained in the previous module. Recapping, the research topics in this module are:

- effectiveness evaluation methodology based upon attribute measurements

- effectiveness and organizational hierarchy
- methodology for "system mode" requirement planning

The methodology for system wide requirement planning has to consider the specifics of the army environment.

It is recommended that as part of this module, this methodology be applied, where the key factors are user's participation and management support. Furthermore, it is recommended that a comparison among the requirements of all command levels and STAMMIS be performed with the objective of identifying what may be required to adapt the current system to the defined needs.

10.3 Design Phase Module

Both research areas suggested - simulation and pilot project - were used in other environments for evaluating effectiveness during the design phase. However, further research is required to adapt them to the army environments as both approaches - by their nature - have to be "tailor made" for the system analyzed.

10.4 Future Trends Module

This module could be started only after some results were obtained in the first two modules. The research in continuous review methodology is aimed at making the MIS effectiveness issue a managerial function that has to be continuously monitored. This could alleviate some of the current problems of the existing system.

Distributed systems and interactive systems are not a new phenomena, however, their impact on effectiveness has to be researched, and the possibility of utilizing those systems for attribute measurement has to be investigated.

10.4 Conclusions and Recommendations

The major findings of this research are as follows:

- there is no one satisfactory approach that can measure and evaluate MIS software effectiveness
- the management group of attributes of the management information metrics received more attention without very much success, as the techniques used are of the behavioral type - most of them based on questionnaires - that have not matured yet, and no drastic change is anticipated in the near future.
- the "information" and "system" group of attributes of the management information metrics has received less attention, however, hold more potential for evaluating effectiveness because of the more objective measurement possible within this group. Also, possibly the attributes here could serve as a surrogate measure of the management group of attributes, thus alleviating some of the evaluation problems there.
- no methodology exists for evaluating the effectiveness of the system based upon measurement of the attributes.
- available techniques for evaluating MIS effectiveness during the design phase do not enable economic justification.
- the requirement planning process does not overtly consider the effectiveness evaluation problem.

It is recommended that an MIS software effectiveness project be designed and implemented, following the modular structure presented above. The implementation policy could use a parallel approach -

implementing all four modules at the same time, or a sequential approach - one module at a time, where the priorities are

- measurement module
- effectiveness module
- design phase module
- future trends module

The sequential approach is recommended. Furthermore, it is recommended that the first two modules be implemented concurrently.

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